Faculty of Resource Science and Technology

DIVERSITY AND CARBON STOCK OF WEED SPECIES IN OIL PALM PLANTATION ESTABLISHED WITH *MUCUNA BRACTEATA* DC. EX. KURZ.

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DECLARATION

I declare that no portion of the work referred to in this dissertation has been submitted in support of an application for another degree of qualification of this or any other university or institution of higher learning.

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"I declare that I have read this work and in my opinion this work is adequate in term of scope and quality for the purpose of awarding a Bachelor's Degree of Science with Honours (Plant Resource and Management Programme)."

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Diversity and Carbon Stock of Weed Species in Oil Palm Plantation Established with *Mucuna bracteata* DC. ex. Kurz.

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ABSTRACT

Existent of weeds in oil palm plantation will decrease the productivity of palm oil and increase cost in term of weed management. Several weed management such as application of herbicides is very popular. However, it may give negative effect as it lead to adverse impact to the environment, public health, and sustainability of biodiversity in long period of time. Therefore, *M. bracteata* apply as a part of cultural method in management of weed. In order to study the effectiveness of *M. bracteata* as cover crop, experiment regarding species diversity, species dominant and carbon stock conducted. Sampling was carried out using square quadrate measuring 1 m x 1 m. All weeds were identified, counted, recorded and dried for dry weight determination. The samples were oven dry at 60 °C for 7 days. Shannon – Weiner Diversity Index obtained were 1.1203 and 3.4003 in area with establishment of *M. bracteata* and area without establishment of *M. bracteata* of oil palm plantations respectively. *Mikania micrantha* H. B. K was the most dominant species in area with establishment of *M. bracteata* (SDR = 0.5560), meanwhile *Trema cannabina* Lour. was the most dominant species in area without establishment of *M. bracteata* (SDR = 0.0923). The estimated carbon stock was 2.1867 tonne $ha^{-1}$for area with establishment of *M. bracteata* and 5.9685 tonne ha^{-1} for area without establishment of *M. bracteata*.

Keywords: Shannon – Weiner Diversity Index, Dominant species, Summed Dominance Ratio, carbon stock

ABSTRAK

Kehadiran rumpai di ladang kelapa sawit akan mengurangkan produktiviti kelapa sawit dan meningkatkan kos dari segi pengurusan rumpai. Beberapa kaedah pengurusan rumpai seperti penggunaan racun rumpai adalah sangat popular. Walau bagaimanapun, penggunaan racun rumpai boleh memberikan kesan negatif kerana ia membawa kesan buruk kepada alam sekitar, kesihatan orang awam, dan keadaan biodiversiti yang mapan dalam tempoh masa yang lama. Oleh itu, M. bracteata digunakan sebagai sebahagian daripada pengawalan secara kultur dalam pengurusan rumpai. Dalam usaha untuk mengkaji keberkesanan M. bracteata sebagai tanaman tutup bumi, eksperimen mengenai kepelbagaian spesies, spesies dominan, dan stok karbon dijalankan. Kaedah pengumpulan sampel rumpai adalah dengan menggunakan plot kuadrat segi empat sama berukuran 1 m x 1 m. Semua rumpai dikenal pasti, dikira, direkodkan dan dikeringkan bagi menentukan berat kering. Sampel dikeringkan di dalam oven pada suhu 60 ° C selama 7 hari. . Indeks Kepelbagaian Shannon – Weiner yang diperolehi adalah 1.1203 di kawasan ladang kelapa sawit yang ditanam M. bracteata dan 3.4003 di kawasan ladang kelapa sawit yang tidak ditanam M. bracteata. Species Mikania micrantha H. B. K. *merupakan spesis yang paling dominan di kawasan ladang kelapa sawit yang ditanam M. bracteata (SDR = 0.5560), manakala Trema cannabina* Lour. *merupakan spesis yang paling dominan di kawasan ladang kelapa sawit yang tidak ditanam M. bracteata (SDR = 0.0923). Sementara itu, stok karbon dianggarkan adalah 2.1867 tan ha^{-1} di kawasan ladang kelapa sawit yang ditanam M. bracteata dan 5.9685 tan ha^{-1} di kawasan ladang kelapa sawit yang tidak ditanam M. bracteata.*

Kata kunc*I: Indeks Kepelbagaian Shannon – Weiner, Spesies dominan, Jumlah Nisbah Dominan, stok karbon*

1.0 INTRODUCTION

1.1 Background Study

Previous decade, oil palm plantation in Malaysia estimated covered 4 million hectares among agriculture land (Hassan, 1994). Nowadays, oil palm plantation in Malaysia as reported by May (2010) become among the important economic field. However, this industry faces a lot of challenges. Pride (2011) mentioned that oil palm industry face problems regarding interruption of weeds and controlling the application of chemical controls such as insecticides and herbicides. Referring to Invasive Species (2006), crop production such as oil palm may reduce down to 10% annually if the weeds dominate the crop area.

Weeds are defined as any plant which grows at undesirable place and time. Plants are termed as weeds because of the undesirability of the plant (Holzner, 1982). Weeds are plants which grow in wrong place and time whenever man wants to grow crops or no crops to grow at all. Weeds are the major component in the oil palm plantation management. Its population is mainly mixture of grasses, sedges, broad-leaved weeds plants and ferns. Some of the importance characteristics of weeds are weeds has rapid seedling growth and the ability to reproduce at young stage. Moreover, it has dual mode of reproduction which are vegetative reproduction and sexual reproduction. Vegetative reproduction is through vegetative organ such as rhizome and tuber and sexual reproduction through seed. For example, *Imperata cylindrica* reproduce through seeds and also through vegetative organ, rhizome. One of the special characteristics of weed is ubiquitous where they exist everywhere especially in agriculture land.

Methods involved in weeds management are cultural, mechanical, chemical, biological and integrated approach such as production system of using livestock to control weeds in oil palm plantation. Those methods sometimes combine as Integrated Pest Management. More than that, International Service for The Acquisition of Agri-Biotech Applications (2011) also reported that weeds in plantation may be overcome by the application of those several methods like hand weeding, tillage and application of herbicides and planting of cover crops.

Mucuna bracteata DC. ex. Kurz belongs to the family of Fabaceae or known as Leguminaceae. It is wild creeper leguminous plant that resistant to drought and shade tolerant too. It has trifoliate leave which dark green in colour and able to grow to size in range of 10 cm to14 cm. it have fibrous root system which commonly develop from the nodes. The nodules developed on the root have irregular size in range 0.2 cm to 2.0 cm. Furthermore, establishment of *M. bracteta* may improve palm oil growth and reduce the period of immaturity (Tui *et al.*, 2005). It produced higher biomass (Matthews, 1999) and their allelopathic property eliminated noxious weeds and grasses.

1.2 Problem Statement

Encroachment of noxious weed may increase the cost for protection, decrease the quality of crop production and lowers the land value. In order to overcome the problems, herbicides applied as 75% of pesticides management for oil palm plantation in Malaysia nowaday. However, Malaysia halted the use of herbicides since 2002 as the toxicity and hazard to human being (Rosli, 2010). More than that, it leads to constitution of 24% of the total production cost of palm oil. Therefore, *M. bractaeata* introduce as cover crop in order to overcome weeds problems in oil palm plantation.

1.3 Objectives

1. To determine the weed diversity in oil palm plantation being established with *M. bracteata.*
2. To determine the carbon stock of *M. bracteata* and weeds species in oil palm plantation being established with *M. bracteata.*

2.0 LITERATURE REVIEW

2.1 Weeds in Oil Palm Plantation

Weeds can be defined as unwanted and undesirable plants (Rao, 2000). Weed consists of sedges, fern, grasses and so on. The diversity of weed always changes due to microclimate of the region. The growth stages differed according to the environmental condition and influence the growth of weed (Wan Mohamed *et al*., 1987). The establishment of weeds interfere the utilization of land, space, light intensity and water source. Moreover, weed may resist to unfavorable and competitive condition to the main crop.

In oil palm plantation, noxious weeds competed and interrupted the growth and development of oil palm and decrease the quantity of production of plantation. Noxious weed species such as *Chromolaena odorata, Mikania cordata* and *Mikania micrantha* as reported by Lam, Lim and Badrulisan (1993) and Pride (2010) always compete with established oil palm in term of nutrients, moisture and sunlight. Worst, those weeds may decrease the production of oil palm plantation. *Imperata cylindrical* believed stunted the growth of young oil palm.

However, previous researches proved that establishment of certain weeds may sustain the diversity of ecological system of nature. Based on Agricultural Research & Advisory Bureae (1999), several plants in oil palm plantation such as *Pueraria javanica, Calopogonium mucunoides,* and *Centrosema pubescens* were beneficial which had been used as early cover crops. The establishment of these weeds may overcome soil erosion problems. Several species of weeds may enhance the fertility of soil such as leguminous species that may fix the nitrogen.

2.2 Weeds Management in Oil Palm Plantation

The weeds in the plantation should be controlled in order to avoid stunted growth and decreasing of crop production (Kuan *et al.,* 1991). Therefore, weed management designed as the solution for the problems in most of agricultural field (Kropff, 1993). Kropff (1993) also stated that, in order to eradicate weeds from a field, the most important is management of weed population.

The weed management systems requires quantitative in behavior of weeds in agro-ecosystems and their effects. Maillet (1991) stated that to propose suitable integrated weed management, we need to analyze every alternative weeding process for economical and sociological parameters. Application of herbicides gives several advantages to the plantation. Effective use of herbicides may reduce the cost and work for physical management and side mechanical damage to the plant during hand weeding.

Esterninos & Moody (1988) mentioned that, application of herbicides is very practical, effective and quite economically in order to manage weeds problems. Sani *et al.,* (1991) added that herbicides functions specifically according to their effect such as systemic herbicides and contact herbicides. Certain herbicide classified according to leaf shape such as narrow and broad-leave. However, Aeschlimann (1991) reported that situation for controlling the weed had deteriorated and emergence of weeds that are resistant to all currently used herbicides. These problem concern mainly small land holders and subsistence crops such as cereals which represent dominant component of human consumption in tropical countries.

2.3 Application of Cover Crops in Oil Palm Plantation

Cover crop help to protect soil from erosion, improve aeration of soil, stabilize the soil moisture, increase the soil organic matter and prevent leaching of nutrients. Kaldivko (2011), had been mentioned that application of cover crop have several beneficial value such as trapping nitrate from leaching into the soil, help in increasing the percentage of nitrogen in soil, avoid soil erosion and suppress weeds. According to Hartley (1977), leguminous cover crops are mostly favorable as they may fix nitrogen. More than that, according to Nadampadom Rubber Estate (2004), the use of weeds such as *Calogonium mucunoides* and *Pueraria javanica* as the cover crops in oil palm plantations helps in conserving the soil and for improving or maintaining the soil structure and fertility. Oil palms growing with the legume ground covers usually show better growth, nutrition and yield (Broughton, 1976).

Furthermore, it have been approve that cover crop may interfere the establishment of noxious weeds as reported by Kladiko (2011) that cover crop may compete with other weeds for survival of nutrient and space. Tendency of cover crop to suppress other weeds as it allelopathic and shading toward other weeds make it chosen. Application of cover crop in oil palm is a common practice in Malaysia nowadays. According to Pushparajah (1973) and Wahab (1977), several species of cover crops such as *Pueraria phaseoloides, Calopogonium caeruleum* and *Centrosema pubescens* are widely used. However, Mathews (2009) reported that several species such as *Mikania, Asystasia* and grasses cannot be overcome by those cover crops. Therefore, application of hand weeding and herbicides need especially during early establishment of cover crops.

According to Mathews (2009), *Mucuna bracteata* have desirable characteristics as cover crop over other type of cover crop. *M. bracteata* grow vigorously and easy to establish. It is no eaten by the cattle. More than that, it is high drought tolerance, high pest and diseases tolerance and also shade tolerance. Those features make it growth vigorously in oil palm plantation. *M. bracteata* also create alleolo chemical to suppress other weeds such as *Panicum maximum* and *Chromoleana ordata* that it competes to. The management of this cover crop also very easy as it only needs small budgets for chemical fertilizer and pruning. As been reported by Tui *et al.* (2005), application of *M. bracteta* may enhance the rate of growth of oil palm.

2.4 Carbon Stock

Every living thing on the Earth composed of carbon as mentioned by Pearson (2005). The carbon lastly will be sequestered and emitted back into the atmosphere. A lot of industrial project and land use today decreased the emission of carbon dioxide to the atmosphere. Besides that, activities such as prevention of deforestation, reducing the impact of logging, and prevention of wetland amd peat land drainage may reduce carbon dioxide to the atmosphere.

Therefore, Clean Development Mechanism (CDM) had been suggested in order to sustain land and forest based on Kyoto Protocol of United Nations Framework Convention on Climate Change (UNFCCC). In order to increase carbon sequestration, project such as tree replantation and reestablishment of grasslands could help. Pearson (2005) also reported that country which focused on industrial activities may invest their projects to other country which not focused on industrial activities in order to reduce carbon dioxide emission to the atmosphere.

For measurement of biomass and carbon stock, Pearson (2005) suggested to use simple harvesting technique. Application of quadrates of 1m x 1m could be used for species such as shrubs and other large herbaceous plant. All plants within the quadrates should be collected. However, plants which outside of the quadrates should be excluded even though it begin from inside the quadrate. Every each species individually weighted for fresh weight. After that, drying process could be done using proper suitable oven at constant temperature of 60 °C within 7 days.

3.0 METHODOLOGY

3.1 Study Site

The study was carried out at Malaysia Palm Oil Board (MPOB) Research Institute, Sungai Asap, Belaga, Bintulu, Sarawak. The survey was conducted in different area which had been established with *M. breacteata* and areas without establishment of *M. breacteata*

3.2 Samples Collection

The sampling was carried out February 2013. For each area, samplings were carried out by using quadrate methods (Kim and Moody, 1983). Hundred quadrates had been established in area with establishment of *M. breacteata* and another hundred in area without establishment of *M. breacteata*. The plants cut at ground level. Leaves, stems, and roots put separately. Those samples packed in plastic bags labeled with the name of species, number of sample plots and study sites

3.3 Species Diversity – Species Richness

The diversity of plants within the area, including all weeds species and *M. bracteata* that present were determined by species richness and species dominance. Species richness calculates as a part of diversity calculation. By using Shannon-Weiner Species Diversity Index (Nolan and Callahan, 2006), the richness of weeds measured. The formula for Shannon-Weiner Diversity Index is as follows:

$$H' = -\sum_{i=1}^{s} pi \ln pi$$

H’ = species diversity index

S = number of species

Pi = the relative abundance of each species, calculated as the proportion of individuals of a given species to the total number of individual in the community: ─

ni = the number of individual in species i

N = the total number of all individuals

3.4 Species Diversity – Species Dominance

Each plant within the quadrates in both areas counted and recorded separately according to species in order to determine the importance dominance of every species in term of Summed Dominance Ratio (SDR) below based on Kim and Moody (1983) method:

Absolute Density (D) = total number of plant for given species in all quadrates

$$\text{Relatives Density (Rd)} = \frac{\text{Absolute Density (D)}}{\text{Total number of plant for all species}}$$

$$\text{Absolute Frequency (F)} = \frac{\text{Total number used in which given species occurs}}{\text{Total number of quadrates used}}$$

$$\text{Relative Frequency (Rf)} = \frac{\text{Absolute frequency of a species (F)}}{\text{Total of the absolute frequency for all species}}$$

Important Value (IV) = Relative density (Rd) + Relative Frequency (Rf)

$$\text{Summed Dominance Ratio (SDR)} = \frac{\text{Important value (I.V)}}{2}$$

3.5 Carbon Stock

All plants within the quadrates were oven dried at C within 72 hours. The dry weight of weed used to calculate carbon stock of the weeds species. As C will achieve the accurate measurement of biomass and carbon storage. Furthermore, in term of getting measure of carbon stock as described by Pearson *et al*. (2005), dry weight of the oven dried matter divide by two. Therefore, carbon stocks of each species were obtained.

$$\text{Carbon Stock} = \frac{\text{Dry weight of samples}}{2}$$

Biomass per hectare = dry weight (g) x100 → (A)

Carbon stock = (A/2) x 1000 (kg)

4.0. RESULT

4.1. Species Diversity – Species Richness

4.1.1. Area with establishment of *M. bracteata*

Table 1: Shannon - Weiner Diversity Index in area with establishment of *M. bracteata* at Malaysia Palm Oil Board (MPOB) Research Institute, Sungai Asap, Belaga, Bintulu, Sarawak.

Species	No. of individuals	*p*	*-p ln p*
Mikania micrantha H. B. K	2513	0.7540	0.2129
Nephrolepis biserrata (Sw.) Schott	236	0.0708	0.1874
Scleria sumatrensis Retz.	162	0.0486	0.1469
Paspalum conjugatum Berg.	129	0.0387	0.1258
Passiflora foetida L.	49	0.0147	0.0620
Digitaria violascens Link	47	0.0141	0.0601
Clerodendrum disparifolium Bl.	39	0.0117	0.0520
Blechnum orientale Linn.	23	0.0069	0.0343
Cyperus compresus	20	0.0060	0.0307
Ageratum conyzoides L.	19	0.0057	0.0295
Costus specious (Koen) J.E. Smith.	18	0.0054	0.0282
Pityrogramma sp.	15	0.0045	0.0243
Vernonia arborea Buch. Ham.	8	0.0024	0.0145
Curculigo vilosa Wall.	7	0.0021	0.0129
Imperata cylindrical (L.) Racuschel	6	0.0018	0.0114
Lygodium flevuosum (L) Sw.	6	0.0018	0.0114
Cyrotococcum accrescens (Trin.) Stapf.	5	0.0015	0.0098
Mimosa pudica Linn.	5	0.0015	0.0098
Merremia umbellata (Linn.) Hallier f.	4	0.0012	0.0081
Musa campestris Becc.	4	0.0012	0.0081
Chromolaena odorata (L.) R.M. King & M. Robinson	3	0.0009	0.0063
Clidemia hirta (L.) G. Don	3	0.0009	0.0063
Axonopus compressus (Sw.) P. Beauv.	2	0.0006	0.0045
Nauclea maingayi Hk. f.	2	0.0006	0.0045
Vitis triloba	2	0.0006	0.0045
Uncaria elliptica	2	0.0006	0.0045
Cyrtococcum oxyphyllum Hochst. ex Steud. J. Stapf	1	0.0003	0.0024
Etlingera coccinea	1	0.0003	0.0024
Ficus grossulariodes Burm. f.	1	0.0003	0.0024
Trema orientalis (L.) Blume	1	0.0003	0.0024
Total	**3,333**		**1.1203**

Table 1 showed Shannon - Weiner Diversity Index in area with establishment of *M. bracteata* at Malaysia Palm Oil Board (MPOB) Research Institute, Sungai Asap, Belaga, Bintulu, Sarawak. Diversity of weeds represented by total of H' equals to 1.1203 and considered as area with low species diversity. Among all the weeds found, Shannon –Wiener Diversity Index H' calculated the richness for each species.

Table 1 and Figure 1 showed that *Mikania micrantha* H. B. K. had the highest species richness with 0.2129 index followed by *Nephrolepis biserrata* (Sw.) Schott (0.1874), *Scleria sumatrensis* Retz. (0.1469), *Paspalum conjugatum* Berg. (0.1258), *Passiflora foetida* L. (0.0620), *Digitaria violascens* Link. (0.0601), *Clerodendrum disparifolium* Bl. (0.0520), *Blechnum orientale* Linn. (0.0343) and *Cyperus compresus* (0.0307).

Whereas, Table 1 also showed the least species richness were only 4 species consist of *Cyrtococcum oxyphyllum* Hochst. ex Steud. J. Stapf, *Etlingera coccinea*, *Ficus grossulariodes* Burm. f. and *Trema orientalis* (L.) Blume which shared the same H' value of 0.0024 respectively. The range of H' values were in between 0.2129 to 0.0024.

Figure 1 showed in the area with establishment of *M. bracteata*, annual weeds (63%) were higher than perennial weeds (37%). In Figure 2, the data showed, shrubs were the highest (60%) compare to grass (20%), fern (13%) and sedges (7%). No small tree or tree seedling found. In term of leave types, Figure 3 showed that 60% were broad leave and 40% were narrow leave. Weeds with herbaceous stem (77%) were the majority compared to woody stem (23%) as referred to Figure 4.